Soldier Modeling for Improved Accommodation and Safety

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Motivation

- Current and future vehicle programs face major challenges in providing adequate accommodation for soldiers while ensuring performance and safety
- Current MIL-STD 1472g lacks detailed information on soldier posture and body shape, including the effects of personal protective equipment (PPE) for seat and vehicle interior layout

- Current design guidance is based on outdated anthropometry and tools that do not adequately represent soldier attributes
- Design standards for seats, restraints, and vehicle interior layout do not take into account PPE and gear

The Seated Soldier Study

Methods:

- Measured 310 soldiers at 3 Army posts
- Driver and squad postures
- Whole-body laser scanning

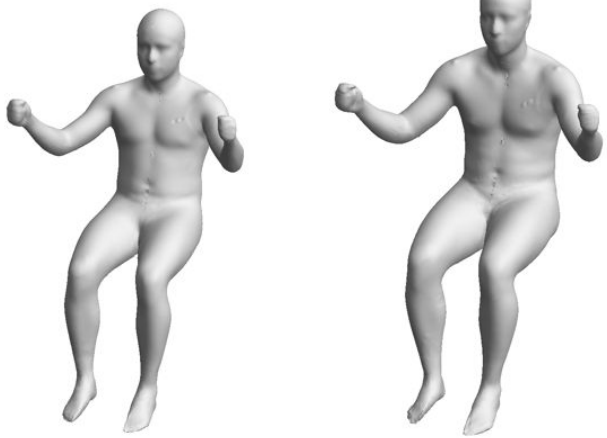
Driver Postures

Standard Anthropometry

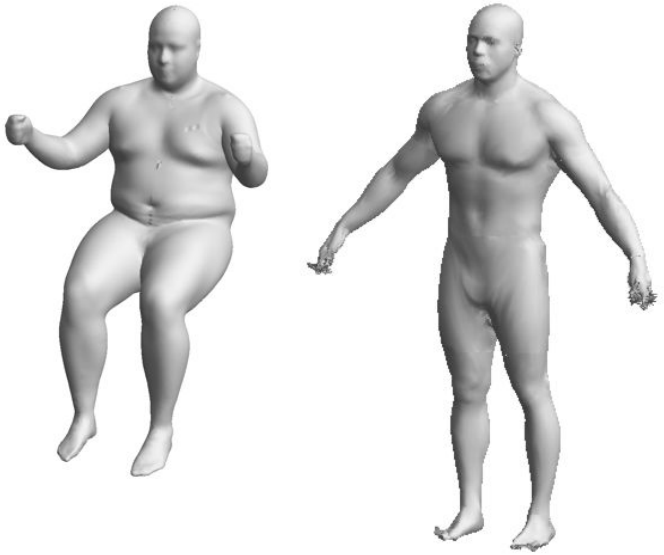
Laser Scans

Squad Postures

S^3: Major Outcomes



Statistical Models of Body Shape



Data on Harness Fit

Clearance Requirements

Driver Posture Prediction

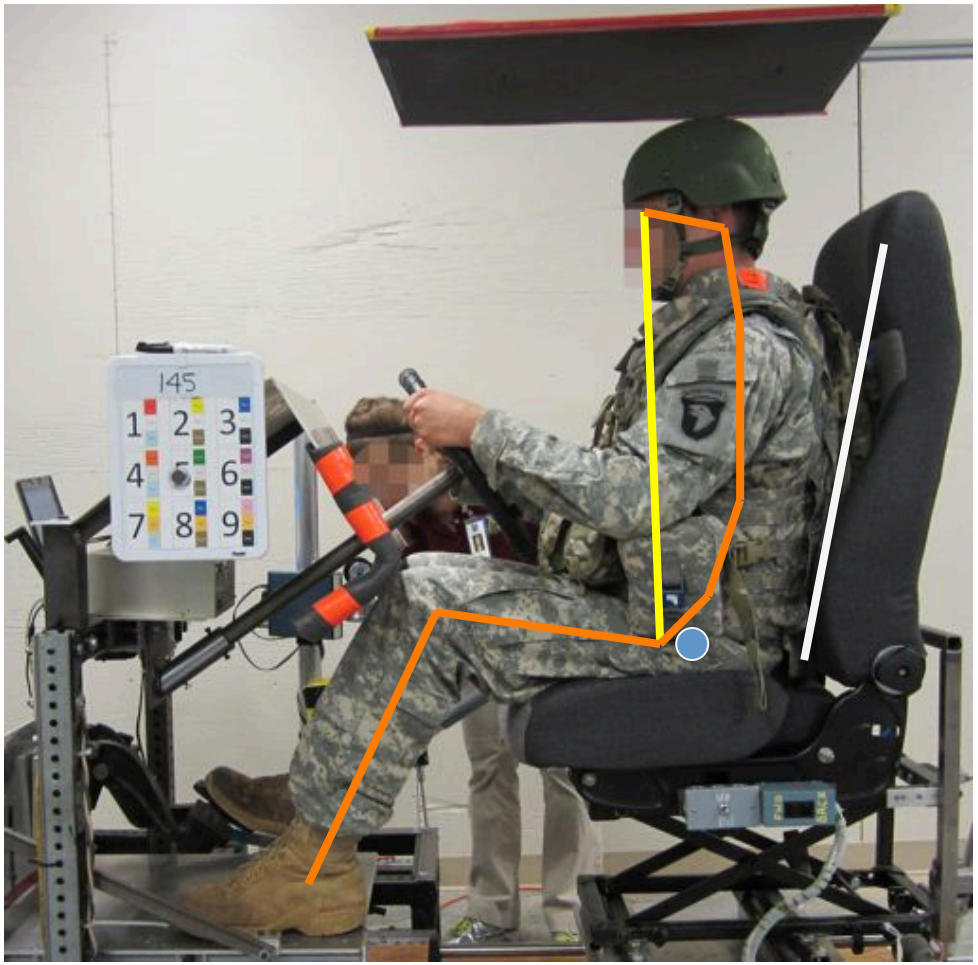
Goal: Predict driving posture

Inputs:

- steering wheel location re accelerator pedal
- driver stature, erect sitting height, body weight, and gear level (ACU, PPE, ENC)

Outputs:

- Seat position
- Seat back angle
- Hip location
- Eye location
- Body segment angles



Squad Posture Prediction

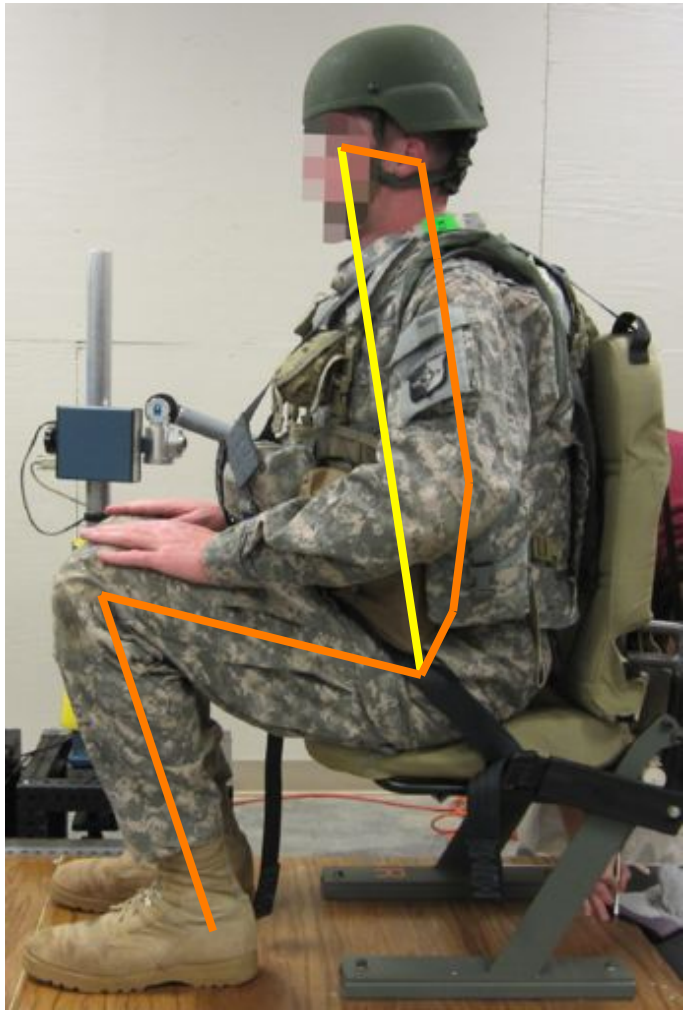
Goal: Predict squad posture

Inputs:

- seat height and back angle
- stature, erect sitting height, body weight, and gear level (ACU, PPE, ENC)

Outputs:

- Hip location
- Eye location
- Body segment angles



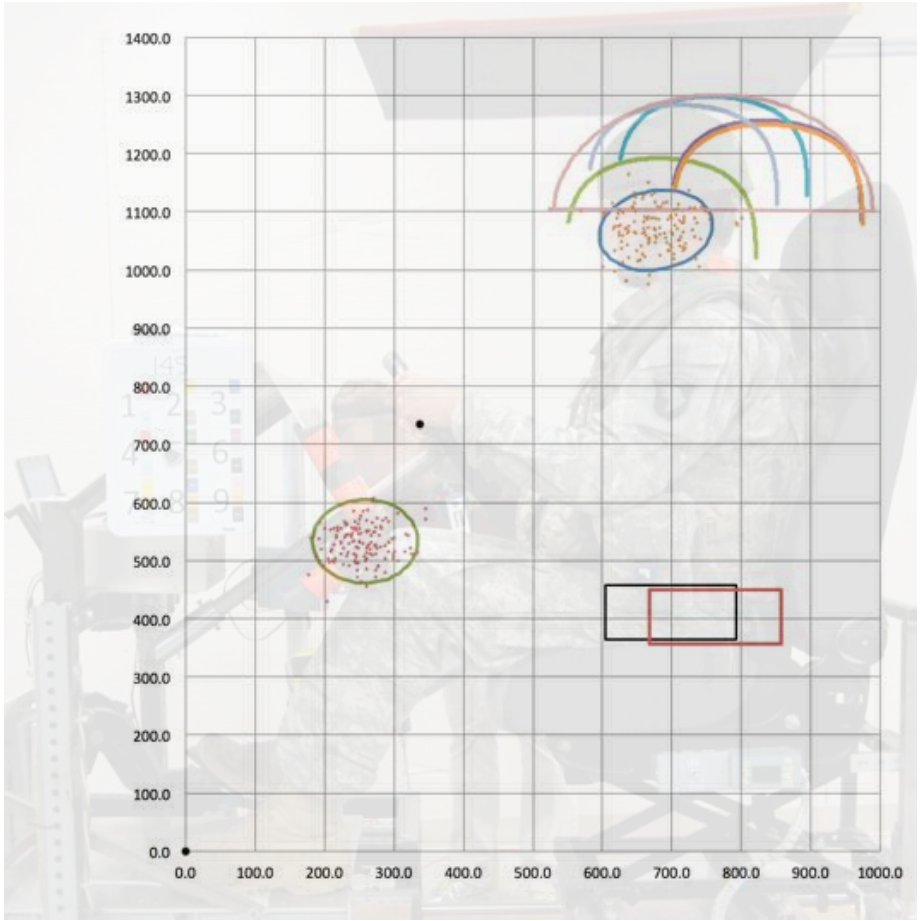
Accommodation Modeling

Background: Design tools embodying human accommodation requirements are needed for vehicle interior layout

Objective: Create soldier-specific design tools using methods developed at U-M

Method: Analyze driver and squad posture and space-claim information from Seated Soldier Study

Status: Driver and squad models completed; preparing documentation and assisting TARDEC in implementation



Seat Index Point Tool

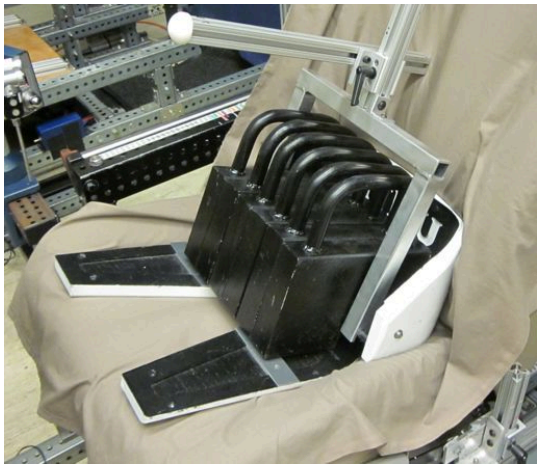
Background: The current standard tool for measuring seats is not practicable for many squad seating conditions

Objective: Evaluate and adapt the ISO 5353 Seat Index Point Tool for military seating applications

Method: Add back angle probe; Comparative measurements of military seats

Status: Completing initial testing; finalizing back angle probe; preparing documentation.

SAE J826



ISO 5353

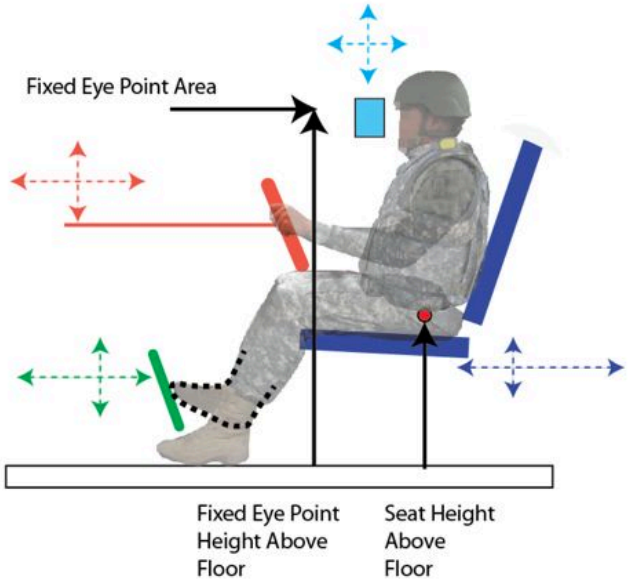
New Driver Configurations

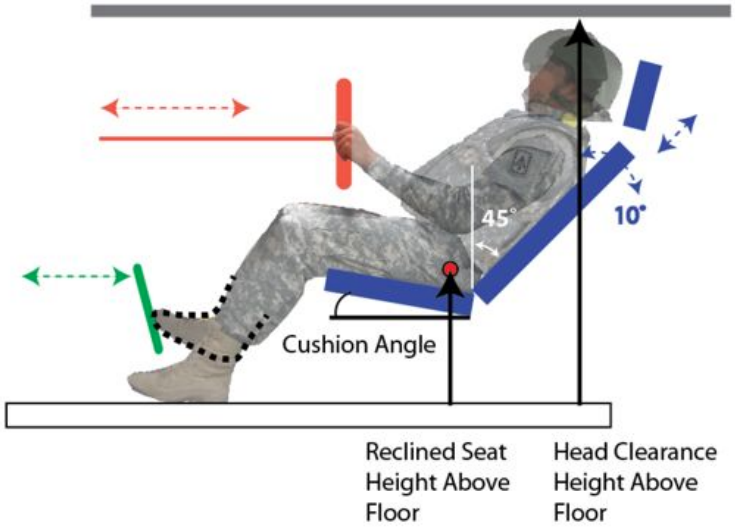
Background: New vehicle designs may include driver workstations markedly different from typical trucks

Objective: Quantify driver posture and component-location preferences for 3 configurations

Method: Field study using soldiers in mockups

Status: Constructing mockups for pilot testing; full-scale testing on an Army post Fall 2014





Equipped Reach

Background: Soldiers wearing heavy gear must perform a wide range of in-vehicle tasks; current data with light clothing are not applicable

Objective: Quantify the effects of body armor and body borne gear on seated reach capability and difficulty.

Method: Laboratory motion-capture study using volunteers with a wide range of body size

Status: Full-scale testing underway (targeting 36 subjects)

Equipped Reach

Crash Protection

Background: Many soldier injuries in vehicles are due to crashes, including rollovers

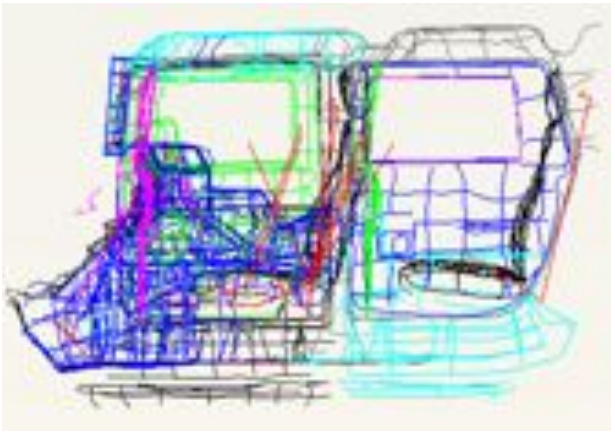
Objective: Optimize airbag/restraint system designs for occupant protection in tactical vehicles in frontal and rollover crashes using sled tests, finite element simulations, and a hybrid optimization process

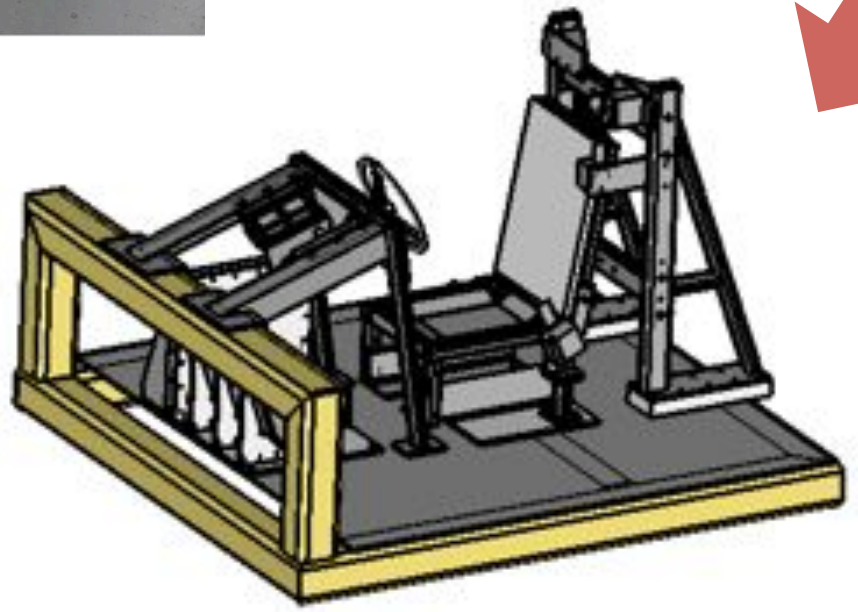
Method:

- Baseline sled tests
- Develop and validated occupant and compartment FE models
- Parametric simulations and hybrid design-space exploration optimization*
- Airbag/restraint optimizations
- Additional sled tests to verify optimized solutions

* Collaboration with Oakland University

Crash Protection





Crash Protection

Baseline Sled Tests: Body Armor

3-Point Belt

5-Point Harness

Crash Protection

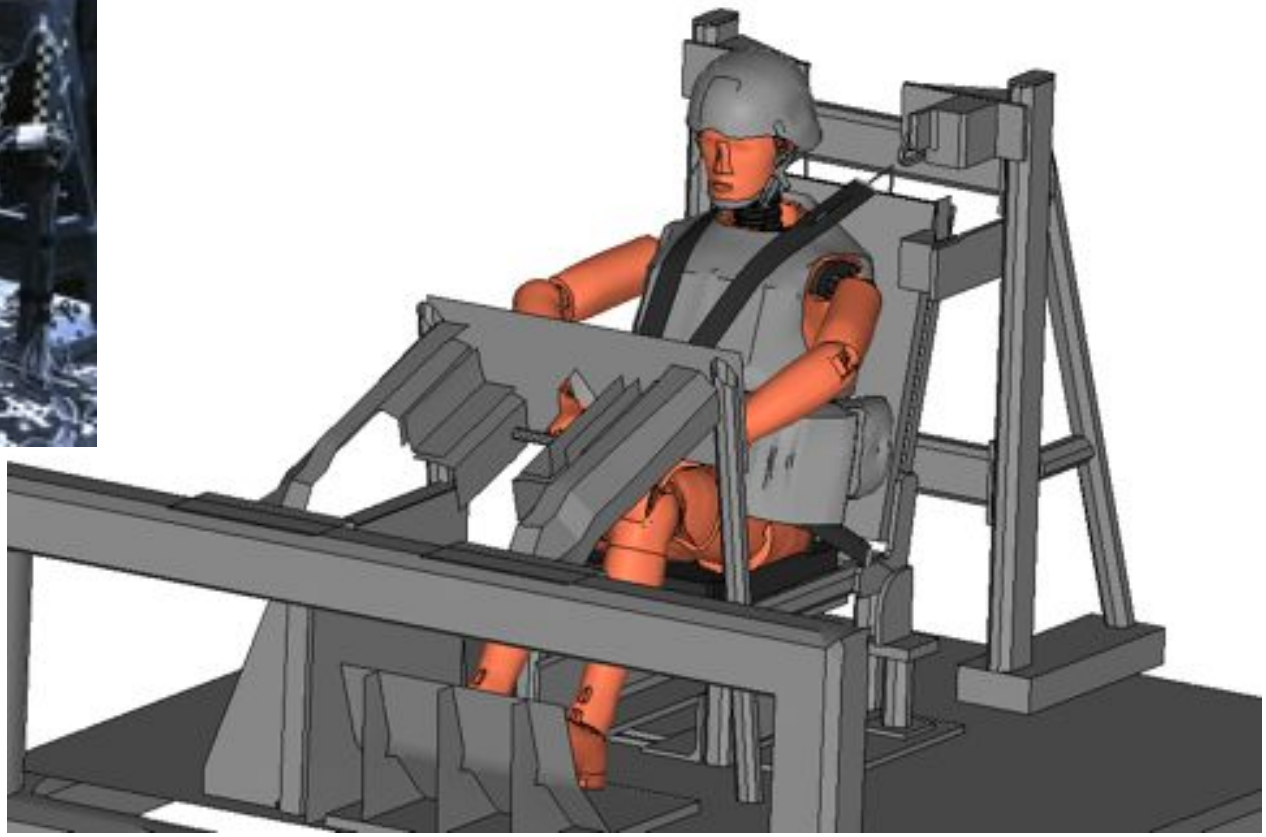
Baseline Sled Tests: Added Gear

3-Point Belt

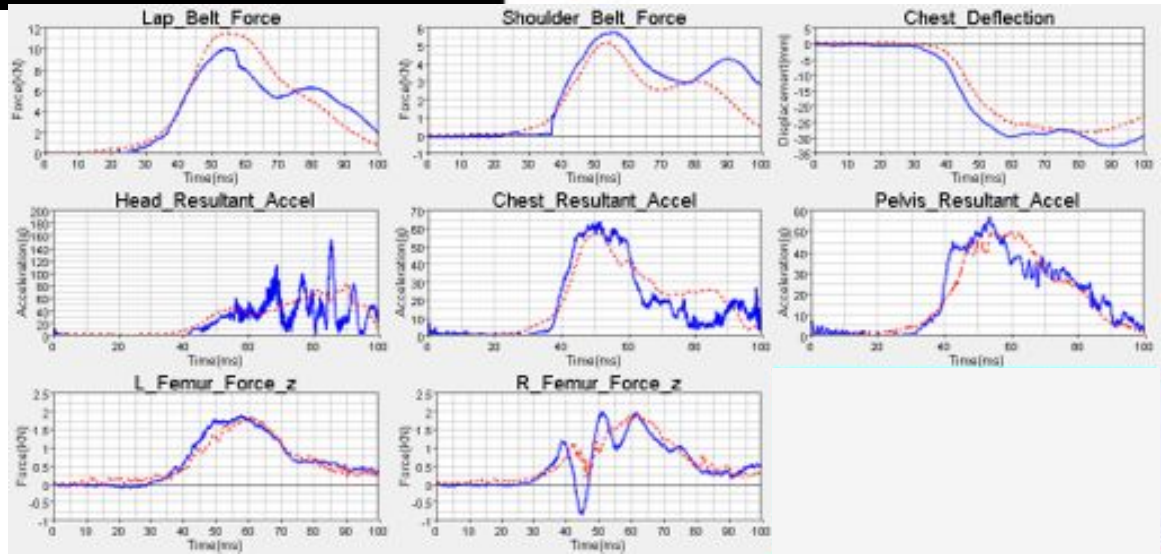
5-Point Harness

Finite Element Models

Midsize Male HIII ATD with ACU, IOTV, and TAP

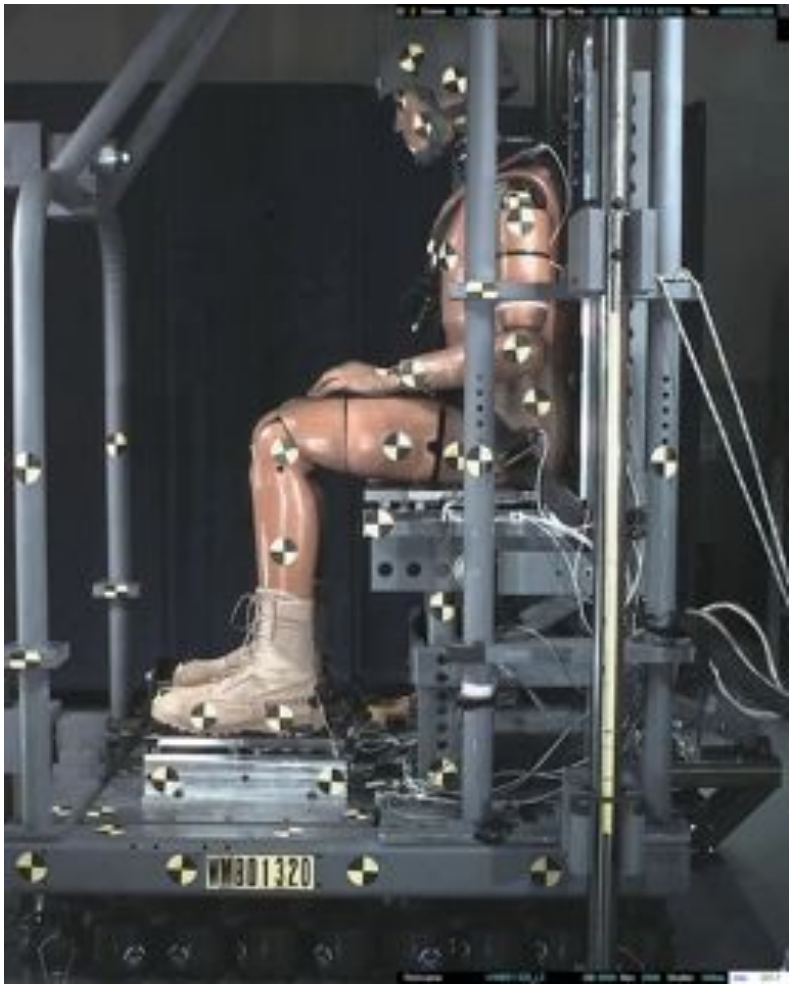


5-Point Baseline – No Gear



WIAMan Activities at U-M

- UMTRI is one of several sites conducting biomechanics testing in support of the Warrior Injury Assessment Manikin program
- The U-M role includes anthropometric specifications for WIAMan and subject positioning guidelines using ARC Seated Soldier Study data.



Pilot Testing with Hybrid-III

Related Activities 2014-15

- Driver posture data collection at an Army post (summer 2014)
- Optimizing vehicle layout taking into account multiple design constraints
- Seat design guidelines, methods, and technology to account for current body dimensions and gear
- Advanced manikin generation, including realistic effects of encumbrance (with NSRDEC)
- HMMWV frontal crash and rollover testing, restraint system optimization using FE models
- FS^3: Extending seated soldier with more female participants?

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